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Some Considerations

Of Mr. Nic. Mercator, concerning the Geometrick and direct Method of Signior Cassini for finding the Apogees, Excentricities, and Anomalies of the Planets; as that was printed in the Journal des Scavans of Septemb. 2. 1669: which Considerations are here delivered in the Latine Tongue, wherein they were written by the Author, as chiefly regarding the Learn'd in Astronomy, viz.

Clarissimi Cassini Methodus

Investigandi Apogæa, Excentricitates & Anomalias Planetarum, breviter Exposita & Demonstrata.

Supponit Cl. Cassinus, ad Planetam in Ellipsi moventem extendi ab utroque foco duas rectas, quarum altera sit *medius*, altera autem *veri motus* linea. Constructio porro talis est;

<p><i>Fig. II.</i> L est Centrum Concentrici A B C D E. B L D est Diameter. B A, B C, B P, sunt intervalla apparentia. D E, D F, D Q, sunt intervalla medi- orum motuum. B E, B F, B Q; item D A, D C, D P, sunt lineæ rectæ. B E secat D A in H; B F secat D C in G; B Q secat D P in R.</p>	<p>R H G est linea recta. B I est perpendicularis ad R H G. I est Centrum Ellipseos. L I est Excentricitas. I O = L I. O est focus, circa quem ordinatur medius motus; L, circa quem verus. I M = I N = L B. M est Apogæon; N, Perigeon; B L M Anomalia vera.</p>
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Demonstratio.

I. Illustrissimus ac Reverendiss. *Sethus Wardus*, quondam in Celeberr. Acad. Oxon. Professor Astronomiæ Savilianus, nunc Episcopus Sarisburiensis, in *Examine Astronomiæ Philolaicæ*, edito Oxon. A. 1653. c. 6. docuit Methodum, ex data Anomalia media Planetarum, investigandi veram; quæ est hujusmodi:

Fig. III. C, est Centrum Ellipseos A E P: F, focus, circa quem ordinatur medius motus. S, focus, circa quem ordinatur verus motus. A, Apogæon. P, Perigeon, E, Erro sive Planeta. A I E, Anomalia media. A S E, Anomalia vera. F E T, linea recta, E T = S E. S T est linea recta.

In \triangle S F T dantur, 1. S F distantia focorum: 2. F T = F E + E S = A P. 3. A F T, angulus externus, sive Anomalia media, æqualis summae angulorum F S T & T. Ergo inveniri potest F S E, sive Anomalia vera, æqualis differentia Angulorum F S T & T. Nimirum

Ut semi-summa laterum FT & FS , ad semi-differentiam eorundem;
Ita Tangens semi-summæ angulorum FST & T , ad Tangentem semi-differentiæ eorundem.

Sed semi-summa laterum FT & FS invenitur, substituendo pro FT æqualem AP , cujus semis est AC , qui additus CS semissi ipsius FS , facit Semi-summam AS , distantiam Planetæ maximam.

Tum, si ex semi-summa AS auferatur latus minus FS , restat semi-differentia laterum FA , æqualis PS , distantia Planetæ minimæ; ut sit

Regula ex Anomalia Media data inveniendi veram:

Ut AS , distantia Planetæ maxima, ad PS , distantiam minimam;
Ita Tangens dimidiæ Anomaliæ mediæ, ad Tangentem dimidiæ Anomaliæ veræ.

Corollar. I. Si continuetur SE usque ad U , ita ut EU sit $=$ ipsi FE , & tota $SU =$ Axi AP ; erit $\triangle FSU$ angulus U semis Prosthaphæreseos FES , ideoque æqualis semi-differentiæ angulorum Anomaliæ mediæ & veræ, h.e. ipsorum AFE & ASE ; & externus $AU =$ semi-summæ eorundem AFE & ASE angulorum, ablata scil. semi-differentiâ UFE ex majori AFE . Unde oriuntur duæ Analogiæ:

1. Ut Sinus semi-summæ Anomaliæ mediæ & veræ AU , ad Sinum semi-differentiæ eorundem, U ; Ita $SU (=$ axi transverso $AP)$ ad SF , distantiam focorum.

2. Ut Sinus semi-summæ Anomaliæ mediæ & veræ, AFV , ad Sinum Anomaliæ veræ FSU ; Ita SU (vel axis AP) ad FU , subtenfam Anomaliæ veræ: Ita quoque semi-axis AC , ad semi-subtenfam UX , vel FX .

Corollar. II. Si in eodem Triangulo FSU , ex subtenfæ FU puncto medio X , erigatur perpendicularis XE ; secabit illa SU in duas partes, quarum altera $UE =$ est lineæ medii motûs FE , altera verò SE est ipsa linea veri motûs.

II. Fig. IV. Sit a Centrum Con-
centrici $chfi$. cdh , est Angulus dimidiæ Anomaliæ
veræ, &
 cad , Diameter, eadêmeque linea dci , Angulus dimidiæ Anomaliæ
Apfidum. mediæ.
 cb , Arcus Anomaliæ veræ, cui re-
spondet ci & dh sunt lineæ rectæ, secantes
 di , Arcus Anomaliæ mediæ. Itaque se mutuò in g .

Ab Intersectionis puncto g demittatur ad cd perpendicularis gb . Erit igitur,

$db.bg ::$ Radius ad tang. bdg vel cdh .

Et $cb.bg ::$ Rad. tang. bcg vel dci .

Ergo

Ergo $db \times \text{tang. } cdh = bg \times \text{Rad.} = cb \times \text{tang. } dci$.

Quare $db . cb :: \text{tang. } dci . \text{tang. } cdh$; hoc est, db erit ad cb , ut tangens dimidiæ Anomalix mediæ ad tangentem dimidiæ Anomalix veræ, adeoque (per Regulam supra expositam) ut distantia Planetæ maximæ, ad distantiam minimam. Quamobrem $db =$ erit distantia Planetæ maximæ, & cb , minimæ, & ab , excentricitati.

Cumque idem eodem modo demonstretur de cæteris omnibus Interfectionum punctis, nimir. Perpendiculares ab ipsis ad cd lineam incidere in punctum b ; oportet, ut recta, jungens ipsas Interfectiones, congruat perpendiculari bgf .

III. Ductâ diametro hak , fiat arcus $kl =$ arcui id , & ducantur ke & hl , secantes se mutuò in p . Ab h in bgf demittatur perpendicularis hr , eadẽque parallela Apſidum lineæ cd ; erit angulus rhs semi-differentia arcuum Anomalix veræ ch , & mediæ di . Tum ab eodem h puncto ducatur recta hb , faciens cum kh angulum $=$ angulo rhs , & occurrens lineæ Apſidum in β . Erit $\triangle a\beta h$ angulus βah mensura arcûs ch , siue Anomalix veræ, & βha semi-differentia Anomalix veræ & mediæ (ex Constructione;) & externus $c\beta h$ (æqualis duobus internis & oppositis βah & βha , adeoque compositus ex Anomalia vera & semi-differentia ejus à media) erit semi-summa Anomalix veræ & mediæ. Ergo, per Corollarii I^{mi} Analogiam priorem; Vt Sinus $c\beta h$, ad Sinum βha ; ita Radius ah , ad Excentricitatem a^2 . Sed supra demonstravimus quoque ab æqualem Excentricitati. Ergo punctum β congruit puncto b .

Tum ex b excitetur ipsi hb perpendicularis bt ; Aio, hanc continuatam incidere in punctum Interfectionis p . Nam Triangula rhs & bht sunt similia, ex Constructione; quemadmodum & $\triangle m bpk$ simile est $\triangle o hgi$, cum eidem peripheriæ ch insistentes anguli $p kb$ & $gi h$ sint æquales, nec non æqualibus peripheriis kl & id insistentes anguli $p kh$ & $g hi$ æquales; quare & tertius hpk æqualis est tertio hgi . Et ex æqualibus $p kh$ & $g hi$ ablatis æqualibus bht & rhs , restant æquales $p hb$ & $g hr$. Vnde sic arguo: $s rh = t bh$, & $r hs = b ht$, Ergo $h sr = h tb$; ergo & Complementa horum ad semi-circulum sunt æqualia, nimir. $r si = b tk$; & $s tg = t kp$, Ergo & $igs = k pt$, quibus ablatis ex æqualibus igh , & $k ph$, restat $hgs = h pt$; & $ghr = p hb$, Ergo & $hrg = h bp$. Sed hrg est rectus. Ergo & $h bp$ rectus est. Cum verò & bht rectus sit ex Constructione, erit tb in directum ipsi bp . Cumque idem eodem modo demonstretur de quavis alia Interfectione linearum ab h & k ad congruentiæ Anomalix veræ & mediæ puncta ductarum; patet, non modo rectam, jungentem interfectiones, transcurram per b punctum; sed & hb , lineam perpendicularem fore ad eandem Jungentem. *q. e. dem.*

Corollarium. Si à quovis puncto Anomalix veræ, puta b , ad respondens punctum Anomalix mediæ i ducatur recta bi ; excitata è Centro Excentrici b , ipsi cbd perpendicularis bf secabit ipsam bi in s eâ ratione, quam linea mediî motûs obtinet ad lineam veri motûs.

Nam per *Corollarium* I^{mi} Analogiam posteriorem, hb est semi-subtensa; Ergò per *Corollarium* II^{um}, perpendicularis erecta ex b , nimir. bt , secat diametrum hk in t eâ ratione, quam linea mediî motûs obtinet ad lineam veri motûs. Ergò & rs (sive bf) secat hi lineam eadem ratione in s ; propter demonstratam modò figurarum $tbbkpb$ & $srhigbr$ similitudinem.

Cæterum ex laudata superius Reverendiss. *Wardi* Methodo inveniendi primam inæqualitatem, non est difficile, alium adhuc modum investigandi Apogæa & Excentricitates, non minus directum & Geometricum, & Observationes quovis admittentem, producere; quem & paucis exponam. Plures modos invenient Astronomi in Reverendiss. Viri *Astronomia Geometrica*, edita *A.* 1656, ad quam eos remitto. Interim

Fig. V. Sint l & d duo foci Ellipseos; t & u duo puncta veri motûs Planetæ; arcus Ellipseos tu ex l spectatus sub angulo tlu , & ex d , sub angulo tdu ; item distantia focorum ld ex t spectatus sub angulo dtl , & ex u , sub angulo dul : Aio, differentiam angulorum tlu , tdu , a qualem esse differentiam angulorum dtl & dul .

Cùm enim trianguli lux tres anguli simul sumpti æquales sint trianguli dtx tribus angulis simul sumptis; si auferantur utrinque æquales lxu & dxt , reliquorum duorum summa $ulx + ldx$ erit = summæ reliquorum $tdx + dtx$, & ab his æqualibus summis si auferantur inæquales, v. g. ulx ex priori, & tdx ex posteriori; reliquorum, lux & dtx , differentia = est differentie ablatorum ulx & tdx ; quod erat propositum.

Centro l , intervallo axis transversî mn , describatur Circulus abc , cujus arcus ab rursus ex l spectatur sub angulo alb , & ex d , sub angulo adb ; item distantia focorum ld ex a spectatur sub angulo lad , & ex b , sub angulo lbd . Ergò rursus differentia angulorum alb & adb = est differentie angulorum lad & lbd . Sed per *Coroll. I.* angulus lad semis est anguli lud , & angulus lbd semis anguli ltd . Ergò horum angulorum lad & lbd differentia = est semi-differentie angulorum lud & ltd ; ergò & angulorum alb & adb differentia = est semi-differentie angulorum ult & udt , quorum prior est intervallum apparens duarum Observationum, posterior autem, intervallum motûs mediî. Datâ igitur horum intervallorum differentia, datur quoque hujus (differentie) semis, nimir. differentia angulorum alb & adb . Sed alb idem est cum ult dato; Ergò datur quoque adb angulus, sub quo peripheria ab spectatur ex d .

Simili modo ostendetur, differentiam angulorum tly & tdy æqualem esse summæ angulorum ltd & lyd ; nec non differentiam angulorum bld & bdc = esse summæ angulorum lbd & lcd . Cumque lbd semis sit ipsius ltd , & lcd semis ipsius lyd ; erit sanè summa ipsorum lbd & lcd = semi-summæ angulorum ltd & lyd , hoc est, differentia angulorum bld & bdc = erit semi-differentiæ angulorum tly & tdy , quorum prior est intervallum apparens duarum Observationum, posterior autem, intervallum motûs medii. Quare, datâ horum intervallorum differentiâ, datur quoque hujus semis, nimir. differentia angulorum bld & bdc . Sed bld idem est cum tly dato; Ergò datur quoque bdc angulus, sub quo periphæria bc spectatur ex d .

Unde liquet, ex datis intervallis Observationum mediis & apparentibus, dari angulos, sub quibus ex d spectantur Circuli abc periphæriæ quovis, interceptæ à lineis veri motûs. Ergò, per *Herigoni Theor. Plan.* l. 1. c. 3. Prop. 12. *Schol.* 1. totidem Circuli segmenta describi possunt, capacia angulorum, sub quibus isti arcus conspiciuntur ex d , quæ segmenta omnia se mutuò interfecabunt in d . Possunt igitur & hac Methodo inveniri Apogæa & Excentricitates Planetarum, delineatione Geometricâ, adhibitis Observationibus quovis; nec difficilius est, Circulos ducere, quàm lineas rectas.

Sed ut demus id, quod verum est, Clarissimi *Cassini* delinationem Geometricam non-nihil expeditiorem esse; verendum est interim, ne, si *αριθμητικῶς* Astronomis expetitam sectemur, Diagrammata requirant enormis magnitudinis, adeoque operosior evadat, quàm ipse Calculus. Ad hunc autem accedentes, utramque Methodum æquipollere deprehendemus.

Adhibeamus enim ex Observationibus *Tychonicis* tres, quæ Dom. *Cassini* Diagrammati quodammodo consentiant; nim. Observationem A, cum *An.* 1604, *Mart.* 28 d. 16 h. 23 m. *Mars* observatus fuit in \approx 18 g. 37 m. 10 s. B, cum *An.* 1587, *Mart.* 6 d. 7 h. 23 m. idem Planeta visus fuit in \approx 20 g. 43 m. 0 s. Denique C, cum *An.* 1600 *Jan.* 18 d. 14 h. 2 m. deprehenderetur in \approx 8 g. 38 m. 0 s. Est igitur inter A & B intervallum apparens 22 g. 54 m. 10 s. & huic respondens medium 25 g. 58 m. 40 s; at inter B & C intervallum apparens 47 g. 5 m. 0 s. & medium 56 g. 21 m. 57 s. Itaque

(1173)

Methodo Cassini, Fig. II.

1. In Triangulo DBH,

Dantur DB 10,00000

DBH 12 | 99

BDH 11 | 45

Queritur BH 9,68106

2. In Triangulo DBG.

Dantur DB 10,00000

DBG 28 | 18

BDG 23 | 54

Quer. BG 9,70653

3. In Triangulo HBG.

Dantur BH 9,68106

BG 9,70653

HBG 41 | 17

Quer. BGH 64 | 95

Cujus Compl. GBI 25 | 05

Si auferas ex GBD 28 | 18

Restat IBD vel IBL 3 | 13

4. In Triangulo GB I.

Dantur BG 9,70653

GIB 90

GBI 25 | 05

Quer. BI 9,66363

5. In Triangulo IBL.

Dantur BI 9,66363

BL (semis τ BD) 9,69897

IBL 3 | 13

Quer. BLI 32 | 31, An. vera,

& LI, 8,67284, Ex-

centricitas.

Methodo Herigoni, Fig. V.

1. In Triangulo dbh,

Dantur db 10,00000

adb externus 24 | 44

bbd 11 | 45

Quer. bb 10,31894

2. In Triangulo dbg,

Dantur db 10,00000

cdb externus 51 | 72

bgd 23 | 54

Quer. bg 10,29347

3. In Triangulo hbg,

Dantur bh 10,31894

bg 10,29347

hbg 41 | 17

Quer. hbg (vel bhi) 64 | 95 = bsg

Et hbi = sgb = 90°

Ergo hbi = gbs = 25 | 05

Ex gbi = gbs + sbi (= hbg - hbi) = 16 | 12

Aufer dbh = hbi - dbi = 12 | 99

Restat gbs + sbi - hbi + dbi = sbd (vel dbi) 3 | 13

4. In Triangulo gbs

Dantur bg 10,29347

bgs 90

gbs 25 | 05

Quer. bs 10,33637

5. In Triangulo dbl,

Dantur bd 10,00000

bl (semis τ bs) 10,03534

dbl 3 | 13

Querit. bld 32 | 31 Anom. vera

Et ld 9,00926 Excentricitas.

Nimir. Ut Fig. II. BL 9,69897, ad LI, 8,67284;

Ita Fig. V. bl 10,03534, ad ld 9,00926.

Ex loco apparenti secundæ Observationis

auferatur angulus Anomalie veræ BLI

Restat locus Apogei

s. g. m. sec.

5 25 43 0

1 2 18 36

4 23 24 24

D 2

Erat

Erat autem reverà ævo *Tychonis* Apogeon *Martis* in Ω $28\frac{1}{2} d.$, à quo deficit iste locus, calculo inventus, solidis quinque gradibus. Porro, Ut B L 9, 69897, \int Ita 5, 18290 Log-us 152369 distantia med. δ tis, ad L I 8, 67284; \int ad 4, 15677 Log-um 14347 Excentricitatis δ tis.

Est autem vera Excentric. δ tis 14179, quam ista, calculo inventa, excedit $\frac{168}{14179}$ particulis.

Cæterum in ratiocinio secundum utramque Methodum instituto notare licet non modò perpetuam Triangulorum similitudinem, sed & Epilogismi congruentiam; ne quis Apogei & Excentricitatis sic inventæ à vero discrepantiam censeat errori Calculi imputandam. Sed nec Observationum vitio contingit; quas in dubium vocare nil aliud foret, quàm principia in Astronomia negare. Itaque restat, ut Hypothesin excutiamus.

Et *Ellipticæ* quidem Orbitæ Inventio sine controversia *Keplero* debetur; sed quibus Accelerationis & Retardationis gradibus incedant Planetæ, definire, non minùs pertinet ad integrandam Hypothesin, quàm ipsius Orbitæ determinatio. Quanquam autem ex Cl. *Cassini* (vel Interpretis ejus) sermone id nusquam apparet; attamen ex Constructione Problematis, & ejus Analyfi, manifestum est, eum supponere, Planetam ex foco superiori videri prorsus æquabili motu incedere. Fuit sanè, cum idem existimaret *Keplerum*, quod ejus Scripta evolventibus liquere potest. Sed cum id Observationibus nequaquam congruere animadverteret, mutavit sententiam, & lineam veri motus Planetæ æqualibus temporibus æquales areas Ellipticas verrere professus est: Punctum autem, ex quo Planeta exactè æquabili motu procedere videtur, nullum omnino extare in hoc Universo, nisi id libratile statuere libeat. Nulli interim puncto propriùs æquabilem videri incesum Planetæ, quàm ipsi foco superiori Ellipseos. Neque inventus fuit hætenus, qui areas *Kepleri* phænomenis satisfacere posse negaret; sed, cum eas Calculo directo exhibere nec ipse nec post eum quisquam potuerit, causati sunt nonnulli, *Keplerum*, nimis indulgentem causis *Physicis*, à *Geometria* diversum abiisse; quasi causæ physicæ repugnent *Geometriæ*, aut minus *Geometricum* sit Problema, quod, nullâ injectâ physicarum causarum mentione, sic proponitur: *Data area Trilini, inter lineas absidum, & veri motus, nec non peripheriam Ellipticam intercepti, invenire Angulum ad Solem.* Habent igitur à *Keplero* responsum, qui illi ἀπευστηριαν objiciunt; nim. *Eant ipsi & Schema solvant.*

Quamvis autem religio fuerit *Keplero*, ab Hypothesi, quam *Naturaliter* esse planè persuasum habebat, recedere; quidni liberum foret aliis periculum facere, num via quævis alia detur, inæqualitatem Planetarum primam directo Calculo investigandi? Ideoque Vir Clariss. *Ism. Bullialdus* aggressus est ratiocinio *Geometrico* indagare, quâ semitâ, & quibus intentionis ac remissionis gradibus conveniret Planetas ferri, ut ab æquabili incesus norma, Astronomis ante *Keplerum* assumptâ, ad eam, quam spectamus, Inæqualitatem perduceremur. Perennant Illustrissimi viri
monu-

monumenta, unde omnem hujus Inventi rationem haurire licet Astrophiliis. Amplexus eandem Reverendiss. *Seth. Wardus*, primum ostendit, paria facere cum linea æquabilis motus circa alterum Ellipseos umbilicum gyrata; deinde & Calculi directi methodo ornavit eam, quam paulo ante recitavimus: Ita ut nil amplius desiderari posset, quàm ut *Urania* felicitibus captis annueret. Cujus quidem nomine suscipere ausus fuit Illustriss. Comes *Paganus*, edito, *biennio post*, ejusdem ferè tenoris Scripto, adeò veram esse Hypothesin, ut deprehensam circa Octantes discrepantiam, Astronomorum insectiæ tributam mallet. At Cl. *Bullialdus*, audiendam potius ipsam Astronomiam ratus, Observatorum ore loquentem, secundis curis, adhibita prioribus Inventis limitatione quadam, discrepantiam illam exterminavit. Unde porro intelligitur, Hypothesin illam, cui Cl. *Cassinus* investigationem Apogeorum & Excentricitatum superstruit, tantundem ferè deficere à vero, quantum Cl. *Bullialdi* limitatio potest, atque ab illo defectu pullulare eum quem supra notavimus, Calculi à Cælo dissensum.

Tantum vero abest, ut de Eximii Viri Inventionem vel minimum delibatum velim, ut quicquid hujus lucubratiuncule non hausi ex Reverendiss. *Wardo*, vel *Herigono*, id omne Ipsi libentissimè acceptum referam, qui ansum nobis præbuit hæc altius considerandi. Nec dubitamus, quin omnia ista multò uberius ac luculentius in promisso *Tractatu* exposita propediem reperturi simus, cujus Editionem maturam, pro eo quo flagramus divinissimæ Scientiæ amore, perquam avidè expectamus.

An Account of Three Books.

I. *Esperienze intorno alla Generatione Degli' Insetti, fatte da Francisco Redi, Accademico della Crusca. In Firenze, A. 1668. in 4o.*

THe Learned and Ingenious Author of this Book, lately come to the Publishers hands, though not yet (which is much disliked by the curious) into our Stationers Shops, doth with much industry undertake therein to evince, that there is no such thing as *Æquivocal Generation* but that every Animal is generated by the seed of another Animal, (its parent,) or, at least, from some Living and un-corrupted Plant, as out of Oak-Apples, and several Protuberances and Excrecencies of Vegetables.

First then, in the asserting of the *Universal* and true Generation of Insects by a peculiar and paternal Seed, the Author positively affirms, that he could never find, by all the Experiments and Observations, he ever made (of which he relateth a great number, by himself made upon all sorts of Animals) that ever any Insects were bred from Flesh, or Fish, or *putrified* Plants, or any other Bodies, but such, as Flies had access unto, and scatter'd their seed upon; he having taken extraordinary care and pains to observe, that alwayes on the Flesh, before it did verminate, there late Flies of the self same kind with those, that were afterwards produc'd thence; and again, that no Worms would ever come from any Flesh in Vessels well cover'd, and defended from the access of Flies; so that to him there is no generation of Insects from any dead Animals, but such as have been fly-blown.

And least it should be objected, that the reason, why in vessels exactly clos'd, no Insect breeds, is the want of Air, necessary to all Generation, He hath carefully covered several vessels with very fine Naples-vaile, for the Air to enter, though Flies could not; but that no worms at all were bred there, notwithstanding that many Flies swarmed about them, invited by the smell of the Flesh inclosed therein.

Secondly, to make out the other part of his Position. *viz.* That these Animals that are not bred by the seed of other Animals, are produced from some live Plant, or its Excre-

Fig. II.

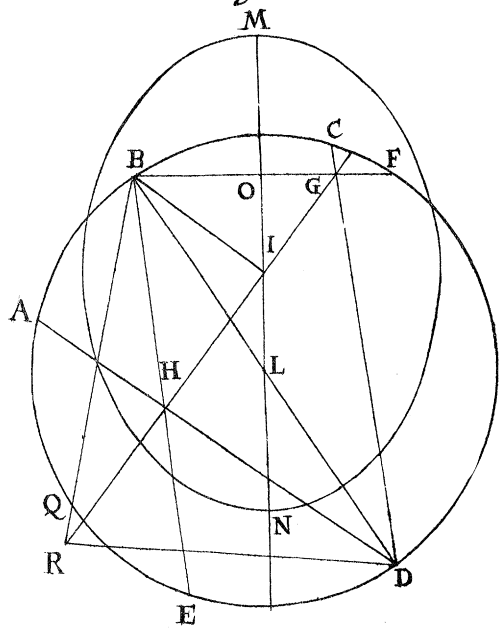


Fig. III.

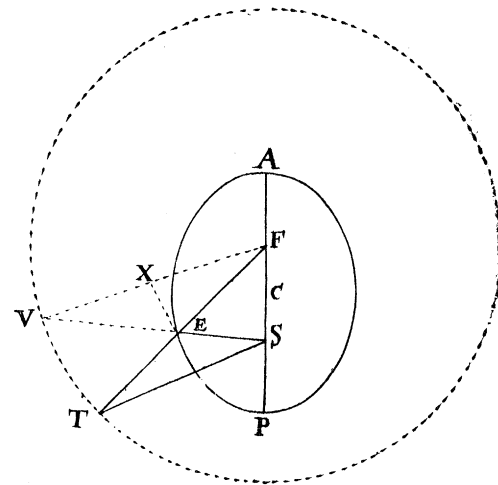


Fig. I.

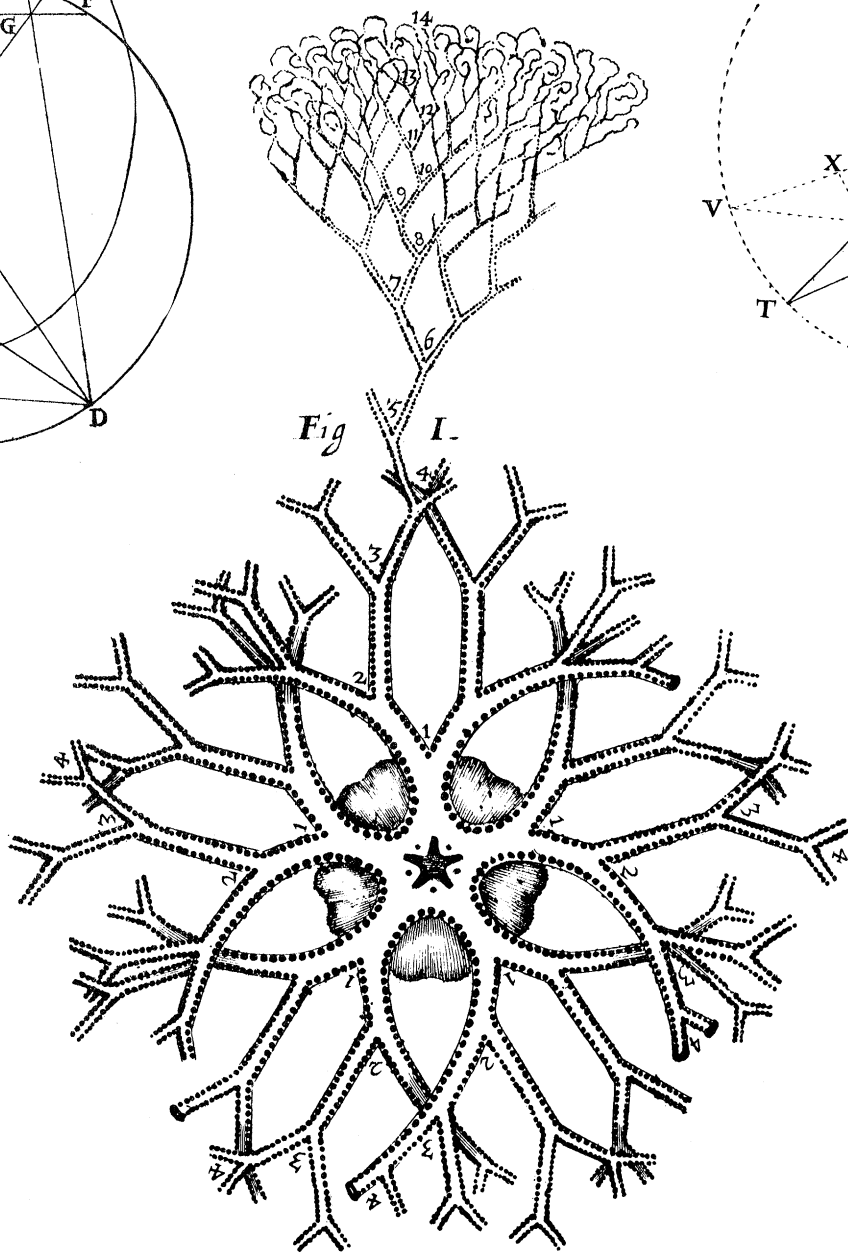


Fig. IV.

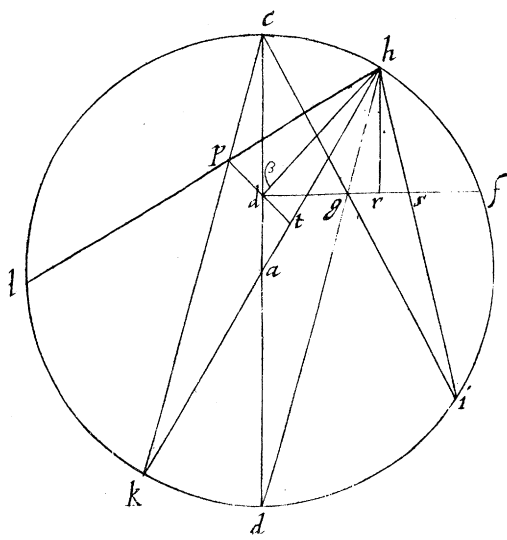


Fig. V.

